REMARKS/ARGUMENTS

This application has been carefully reviewed in light of the Office Action dated April 23, 2009. Claims 1-7, 9 and 10 remain in this application. Claim 1 is the independent Claim. Claims 1 and 4 have been amended. Claim 8 is canceled without prejudice. New claim 10 is added. It is believed that no new matter is involved in the amendments or arguments presented herein. Reexamination and reconsideration of the application, as amended, are respectfully requested.

The present application is generally directed to a silicon based thin film solar cell including a silicon based low refractive index layer, a silicon based interface layer and a back electrode on the backside of a photoelectric conversion layer. (Applicant's specification, at FIG. 1).

CLAIM REJECTIONS UNDER 35 U.S.C. § 102

Claims 1, 2 and 9 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Watanabe (US 4,781,765). Applicant respectfully traverses this rejection and amends claim 1 to clearly distinguish over all references of record. Claim 1 reads as follows:

> A silicon based thin film solar cell, wherein a conducted type silicon based low refractive index layer, a silicon based interface layer, and a back electrode are disposed and contact one another in this order on a backside of a photoelectric conversion layer observed from a light incident side, wherein the silicon based interface layer comprises a crystalline silicon component in the layer.

In the present invention, a silicon based interface layer disposed between a silicon based low refractive index and a back electrode layer has small contact resistances such that small series resistance is provided (see published application,

at paragraph 0020). This feature advantageously provides a solar cell that exhibits sufficient light trapping effect to keep a series resistance of the solar cell small even if a layer having a low refractive index is disposed (paragraph 0014). Watanabe fails to disclose or suggest this feature.

Watanabe is directed to a photovoltaic device for resisting thermal degradation of conversion efficiency without deterioration of the initial conversion efficiency. Watanabe teaches that such degradation is caused by an undesired element diffused from the back electrode into the semiconductor layers due to a weakness of Si-Si bonding in the amorphous Si:H structure (col. 2, lines 61-68). Watanabe's solution to this problem requires a stack of an alloyed amorphous silicon first type n-sub-layer $3n_{11}$ an amorphous silicon second type n-sub-layer $3n_{12}$ (col. 2, lines 43-55 and col. 3, line 1-10). Therefore, a second type n-sub-slayer $3n_{12}$ is essential in Watanabe. However, if the n-sub-layer $3n_{12}$ is replaced with a crystalline containing layer, the thermal degradation problem would no longer occur, such that the first type n-sub layer $3n_{11}$, which is a key feature of Watanabe, is rendered unnecessary and irrelevant. Therefore, Watanabe teaches away from the use of a crystalline silicone component in the layer $3n_{21}$, and such a modification would change the principle of operation of Watanabe (MPEP § 2143.01).

The present invention, by contrast, includes a crystalline silicon component and a silicon based interface layer 4n to decrease the contact resistance, thereby improving the conversion efficiency even when the silicon based low refractive index layer has a higher oxygen content (paragraphs 0018-0020). None of the cited references teaches the benefit of lower contact resistance provided by a crystalline silicon component.

Accordingly, since Watanabe does not teach each and every single limitation of claim 1, it cannot anticipate claim 1 or claims 2 and 9 dependent thereon. Withdrawal of this rejection is respectfully requested.

CLAIM REJECTIONS UNDER 35 U.S.C. § 103

Claims 3-5 and 7 are rejected under 35 U.S.C. § 103 as obvious over Watanabe. Claims 6 and 8 are rejected as obvious over Watanabe in view of Nakamura (JP 59035016). Applicant respectfully traverses this rejection.

Each of claims 3-5 and 7 depend from independent claim 1 and are allowable for at least the same reasons discussed above. With respect to Claim 3, the advantageous light trapping effect of the present invention is provided by the most abundantly existing constituent element, excluding silicon, in the silicon based low refractive index layer having not less than 25 atomic %. Applicant submits that one skilled in the art would not be motivated to employ an oxygen content of not less than 25 atomic %. For example, Watanabe suggests that a higher oxygen content of over 25 atomic % lowers the initial values of the conversion efficiency. In particular, the first type n-sub-layer $3n_{11}$ having oxygen content of 13-22 atomic % shows an initial conversion efficiency (η_0) of about 9%, while the 25 atomic % oxygen demonstrates η_0 of about 7% (FIG. 3B). In addition, a conventional device which does not include a first type n-sub-layer $3n_{11}$ provides a η_0 of 9.05% (Table II). Consequently, the inclusion of a first type n-sub-layer $3n_{11}$ contributes only to thermal degradation, and not a high initial conversion efficiency such that an oxygen content of over 25 atomic % decreases the initial efficiency. Thus, in order to increase the conversion efficiency, one of ordinary skill in the art would use a layer having an oxygen content of less than 25 atomic %.

The present invention, by contrast, includes a silicon based low refractive index layer of not less than 25 atomic % provides higher conversion efficiency (paragraph 0046 and Table 1). Furthermore, an oxygen content of not less than 25 atomic %, corresponding to a refractive index of lower than 2.5, results in a higher conversion efficiency. In view of Watanabe, this feature of the present invention provides unexpected results and demonstrates criticality (FIGs. 1 and 5, paragraphs

0048-0049). The unexpected advantages is enhanced through the combination of the silicon based low refractive index layer having the most abundant constituent element not less than 25 atomic % and the silicon based interface layer including a crystalline silicon component.

Furthermore, claim 4 recites "the most abundantly existing constituent element is oxygen." In other words, the claim requires oxygen to be the most abundant element in the whole thin film solar cell. Applicant submits that Watanabe fails to disclose or suggest this feature. Page 3 of the Office Action cites Watanabe at column 7, lines 14-18 for teaching the first type sub-layer containing oxygen at less than 50%. However, since the amounts of other elements are not disclosed for the sub-layer or any of the other layers, it is not possible to determine which element is the most abundant within the photovoltaic device.

Moreover, with respect to claim 5, the silicon based low refractive index layer has a thickness of not less than 300 angstroms. The Office Action states that increasing the thickness of the low refractive index to increase the region for blocking undesired diffusion from the back electrode would have been obvious since adjusting the result effective variable of thickness involves only routine skill. Applicant traverses this contention that increasing thickness is known to be a result effective variable.

In order to conclude that increasing thickness is a matter of routine experimentation, M.P.E.P. § 2144.05 states "A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977) (The claimed wastewater treatment device had a tank volume to contractor area of 0.12 gal./sq. ft. The prior art did not recognize that treatment capacity is a function of the tank volume to contractor ratio, and therefore the

parameter optimized was not recognized in the art to be a result- effective variable.)."

In Watanabe, there is no recognition that diffusion blocking is enhanced through increasing thickness. At best, Watanabe teaches "the first type n-sub-layer $3n_{11}$ will block the diffusion of the undesired element." (col. 3, lines 4-6). Therefore, it is equally plausible that the composition or the location of the layer $3n_{11}$ is the result effective variable that blocks diffusion instead of thickness. Thus, applicant submits that thickness is not recognized in Watanabe as a result-effective variable such that one of ordinary skill would not find obvious to provide a thickness of not less than 300 angstroms in the low refractive index layer.

Furthermore, the limitation in claim 5 of the thickness of not less than 300 angstroms demonstrates criticality in providing a light trapping effect that results in an increased conversion efficiency (FIG. 6 and paragraphs 0043 and 0049).

In view of the foregoing, it is respectfully submitted that the combination of Watanabe and Nakamura cannot render claims 3-8 obvious since they fail to teach or suggest each and every claim limitation. Accordingly, withdrawal of the rejections are respectfully requested.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4755 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: July 16, 2009

By: 
Natalie A. Davis, Ph.D.
Registration No. 53,849

1999 Avenue of the Stars, Suite 1400
Los Angeles, California 90067
Phone: 310-785-4600
Fax: 310-785-4601